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(12) # EUROPEAN PATENT APPLICATION

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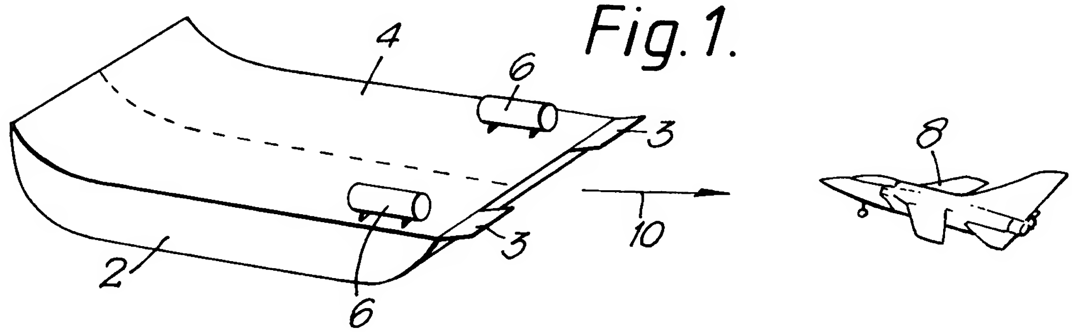
(54) **Landing of aircraft.**

(57) For assisting the landing of aircraft (8) on aircraft carriers (2), and in other situations where runway area is limited, a headwind generator (5 or 6) is proposed to direct a headwind at the aircraft as it comes in to land. This allows the aircraft to have a low speed relative to the aircraft carrier (or ground) and a high air speed, thus allowing controlled descent.

Fig.1.



EP 0 579 508 A1

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This invention relates to apparatus for use during a landing phase of flight of an aircraft, and more particularly relates to apparatus for assisting aircraft to land where only a small area of runway is available, for example when landing on an aircraft carrier.

It is common practice for aircraft carriers to proceed at a speed of, say, 20 knots when aircraft are taking off from or landing on the deck. This provides the aircraft with a headwind which is advantageous in both landing and taking off manoeuvres. Furthermore, the advantageous effect of the headwind can be increased by steering the ship so that it heads into the wind, thus increasing the "wind-over-deck" speed still further. However, despite the beneficial effects of the increased wind-over-deck speeds, there are still only a very few aircraft which have a short take-off and landing capability which allows them to take-off and land on aircraft carriers without expensive and heavy modification.

It is an object of the present invention to provide a means of assisting aircraft to land in situations where only a small runway area is available, such as on an aircraft carrier.

According to the invention there is provided apparatus for use during a landing phase of flight of an aircraft, the apparatus comprising an aircraft headwind generator positioned in the vicinity of where the aircraft is to land for generating a headwind for said aircraft.

Thus, the wind-over-deck speed may be increased by the headwind generator.

The headwind generator may comprise at least one jet engine or propeller.

Advantageously, the headwind generator may comprise of either two headwind outlets, positioned in the aircraft landing vicinity one on each side of the aircraft landing trajectory, or a headwind generator positioned under the level of the landing area, the outlet for the air flow being via a series of louvres.

To enable this second method to generate the required headwind a plenum chamber is created below the louvred deck into which air is blown from below, in front, from behind or from either side. The entry position of the air to the plenum chamber is not considered critical since the louvres are arranged such that the air can only exit through the louvred openings and along the deck.

For a better understanding of the invention an embodiment of it will now be described by way of two non-limiting examples, with reference to the accompanying drawings in which:-

Figure 1 shows an aircraft coming in to land on an aircraft carrier on which an above ground/deck level headwind generator is fitted in accordance with the present invention;

Figure 2 shows an aircraft coming into land on an aircraft carrier on which an under ground/deck level headwind generator is fitted in accordance with the present invention.

Figure 3 shows the proposed headwind steering control mechanism to be used in conjunction with either headwind generation method shown in figures 1 & 2.

Figures 4A and 4B show the aircraft flying towards the headwind during landing;

Figure 5 is a graph illustrating an example landing trajectory of an aircraft.

Figure 1 shows an aircraft carrier (2) including a flat deck area (4) on which aircraft may land, and from which they may take off. Two above ground/deck level headwind generators (6) are positioned one on each side of the deck area (4) and may be directed inwards so that the respective headwinds merge. In the illustrated example the headwind generators (6) are positioned on the rearmost portion of the deck (4), i.e. the portion nearest the aircraft (8) as it comes in to land, although it should be appreciated that the headwind generators (6) could be positioned elsewhere on the deck depending on the requirements in any particular case. A headwind steering control mechanism (3) is shown positioned at the aft end of the deck to enable contorl of the vertical angle of the headwind away from the deck. Also, a drive arrangement may be provided which allows the orientation of the headwind generators to be varied.

Figure 2 shows the same aircraft carrier (2) as detailed in Figure 1, but with the above ground/deck level headwind generators removed and substituted for an underground/deck level headwind generation system. The headwind generating engines (5) are positioned below ground/deck level (4) and blow air via a plenum chamber (9) through a series of louvres (7) shown aligned laterally across a portion of the ground/deck area (4). The flow of the air through the succession of the louvred exits (7) produces a gradually thickening jet of air directed aft of the aircraft carrier deck. A system of under deck thermal generators ducted to produce a flow of hot gasses above the deck level of an aircraft carrier has been patented under Patent No. 1,036,015 at the London Patent Office. This invention was designed primarily for use as a fog clearing mechanism this is achieved by heating the surrounding atmosphere. No claim is made with reference to a headwind generator to facilitate lower groundspeed landings for aircraft as detailed in this application. The direction of the jet of air emanating from the louvred system can be varied in elevation to accommodate differing approach angles for different landing craft using the flap mechanism (3).

Both headwind generators i.e. 5 & 6 may employ propellers or they may be jet engines. In combination, the generators are capable of producing 20,000 bhp in the former case, and 60,000lb of jet thrust in the latter case. For example, suitable headwind generation could obtained from (4) Tyne turboprop engines or one RB211

jet engine.

As an aircraft (8) begins its landing phase of flight, the headwind generators either 5 or 6 are activated, thereby producing a headwind in the general direction of arrow (10). The aircraft (8) and/or the ship (2) must locate the centre of the headwind (12) (as illustrated in figures 4A and 4B) formed by the combination of the outputs of the two headwind generators (6) or the flow of the underground/deck level louvred gasses (5) so that the aircraft (8) may take an appropriate flight path. It is thought that a flight path just above the centre of the jet will be stable in altitude, and therefore advantageous.

To assist the aircrew and persons controlling the direction of the headwind, a form of flow centreline visualisation is necessary. Smoke or some other marking medium maybe added to the headwind flow in either a continuous or intermittent manner to allow the headwind flow to be visualised. Alternatively a lightweight streamer in the form of a rope or a tape which is non-injurous to the aircraft or its engine maybe trailed from the carrier deck to again indicate the centreline of the headwind flow.

The headwind generators (5 & 6) do increase the wind-over-deck speed, thereby reducing the aircraft speed relative to the ship's deck (4) required for a given amount of wing lift. Ideally, the aircraft speed relative to the deck (4) would be zero - so allowing a near-vertical decent of the aircraft (8) onto the deck (4) whilst the aircraft (8) is still fully wing-born. In practice, it is thought touch-down speeds of less than 20 knots relative to the aircraft carrier will be typical.

Various published data sources, supported by our research, indicate that a stream of moving air mixes with the surrounding air at a consistent rate such that it has a reducing velocity and increasing area downstream.

The typical centreline velocity ratios and diameters at downstream distances expressed in diameters of the initial jet diameter are:-

DISTANCE	VELOCITY RATIO	DIAMETER
0	1.00	1.0
15	0.50	2.0
30	0.25	4.0
60	0.125	8.0

Thus, an initial jet velocity of, say, 120 knots with a jet of 10 metres in diameter will reduce to 60 knots at a distance of 150 metres from the outlet, 30 knots at 300 metres, etc. In practice a smaller but higher speed jet may be used, as many a non-circular jet.

For an example aircraft, having a notional approach speed of 120 knots, a deceleration capability of up to 0.3 "g" is available at this speed by reducing aircraft thrust to idle, at a lift/drag ratio of about 3, in the landing configuration.

By parametrically varying jet diameter and jet velocity it may be possible to find combinations which will allow the aircraft to decelerate relative to the aircraft carrier (2) so as to arrive at the deck (4) in a "hovering" condition at 120 knots air speed, but zero ground speed. The graph in Figure 5 shows an example of the way in which the air speed of an aircraft, the ground speed of the aircraft and the jet velocity (indicated by lines 14, 16 and 18 respectively) might vary during landing. The point 20 represents 5 seconds before aircraft landing, and the point 22 represents 10 seconds before landing.

Although, in the first example illustrated, two headwind generators (6) are used, one on each side of the deck area (4), and in the second example illustrated a number of generators (5) are used below deck level, various other configurations are also possible. However, these configurations illustrated do offer the advantage that the aircraft 8 can fly either between the generators in Figure 1, or over the louvres in Figure 2, therefore allowing it to take off from the deck (4) again after it has touched-down if there is insufficient time for the aircraft to decelerate and successfully land. Alternatively, just one headwind generator, or any other number could be employed. It may be desirable to have one wind generator which supplies several headwind outlets positioned appropriately around the deck.

A further effect of the headwind generator producing a rearwards-directed headwind is to increase the forward speed of the aircraft carrier (or cause movement if the ship is stationary prior to operation of the generators). This feature is particularly advantageous if the carrier's main propulsion system fails.

Claims

1. Apparatus for use during a landing phase of flight of an aircraft, the apparatus comprising an aircraft headwind generator positioned in the vicinity of where the aircraft is to land for generating a headwind for said aircraft.

2. Apparatus according to Claim 1, wherein said headwind generator comprises at least one jet engine or propeller.

3. Apparatus according to Claim 1 or Claim 2, wherein said headwind generator comprises two headwind outlets, positioned in the aircraft landing trajectory.

4. Apparatus according to Claim 1 or Claim 2 wherein said headwind generator comprises of one or more engines positioned below ground/deck level and the exhausted air being ducted out to ground/deck level via a series of angled louvres positioned in the aircraft landing trajectory.

5. Apparatus according to any of the preceding claims wherein the said headwind "over deck" maybe directed in a vertical plane by use of a headwind steering flap positioned in some location along the centreline between the headwind gas outlet and the aircraft trajectory.

Fig.1.

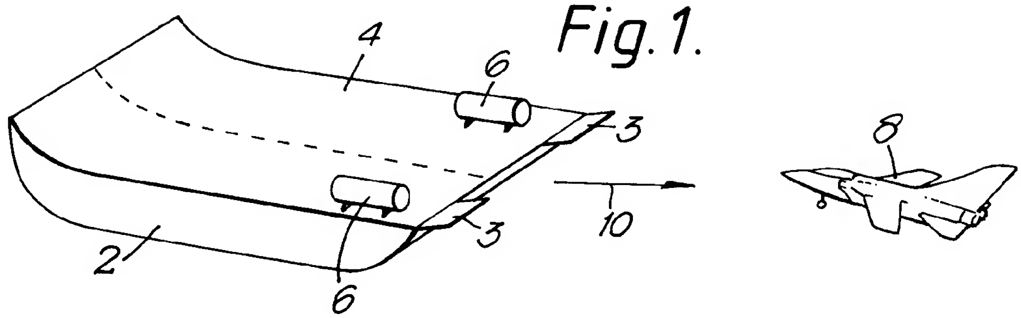


Fig.2.

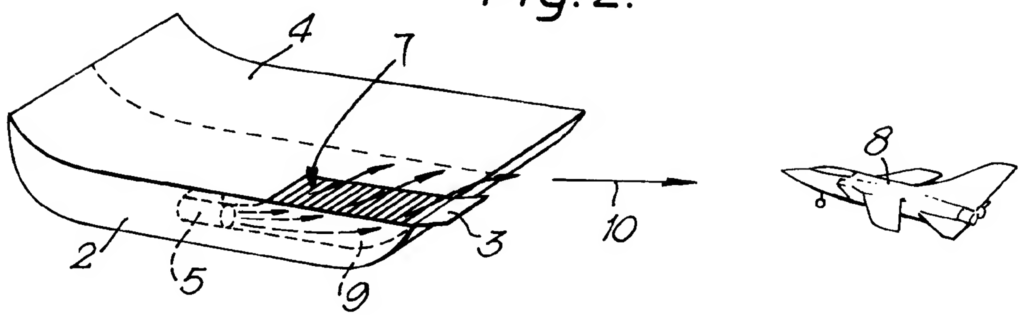


Fig.3.

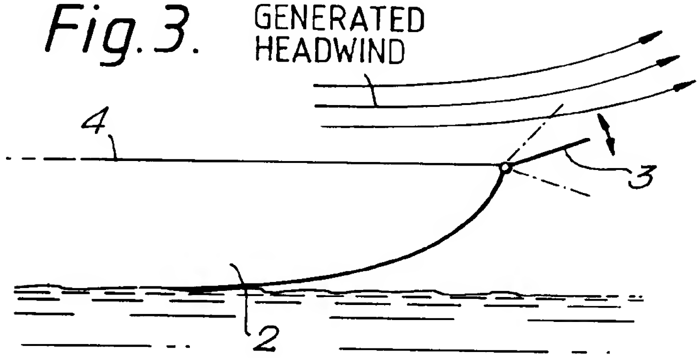


Fig.4A.

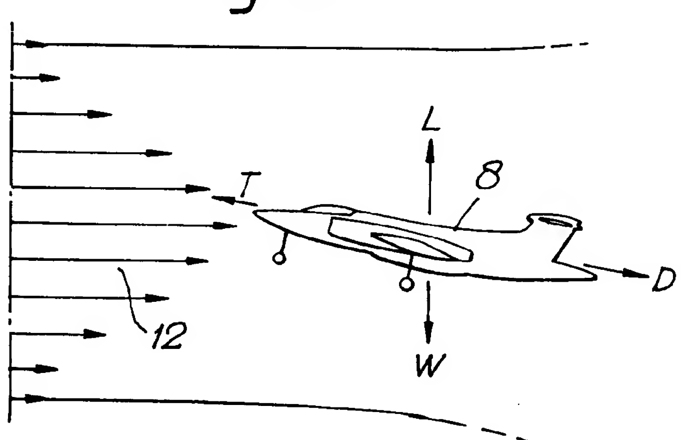


Fig.4B.

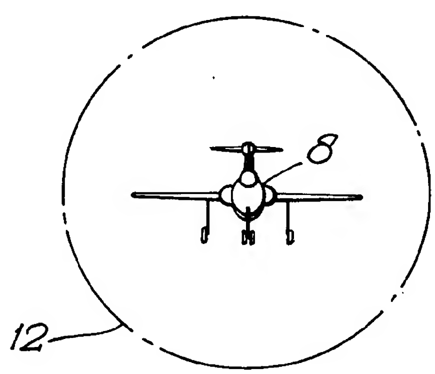
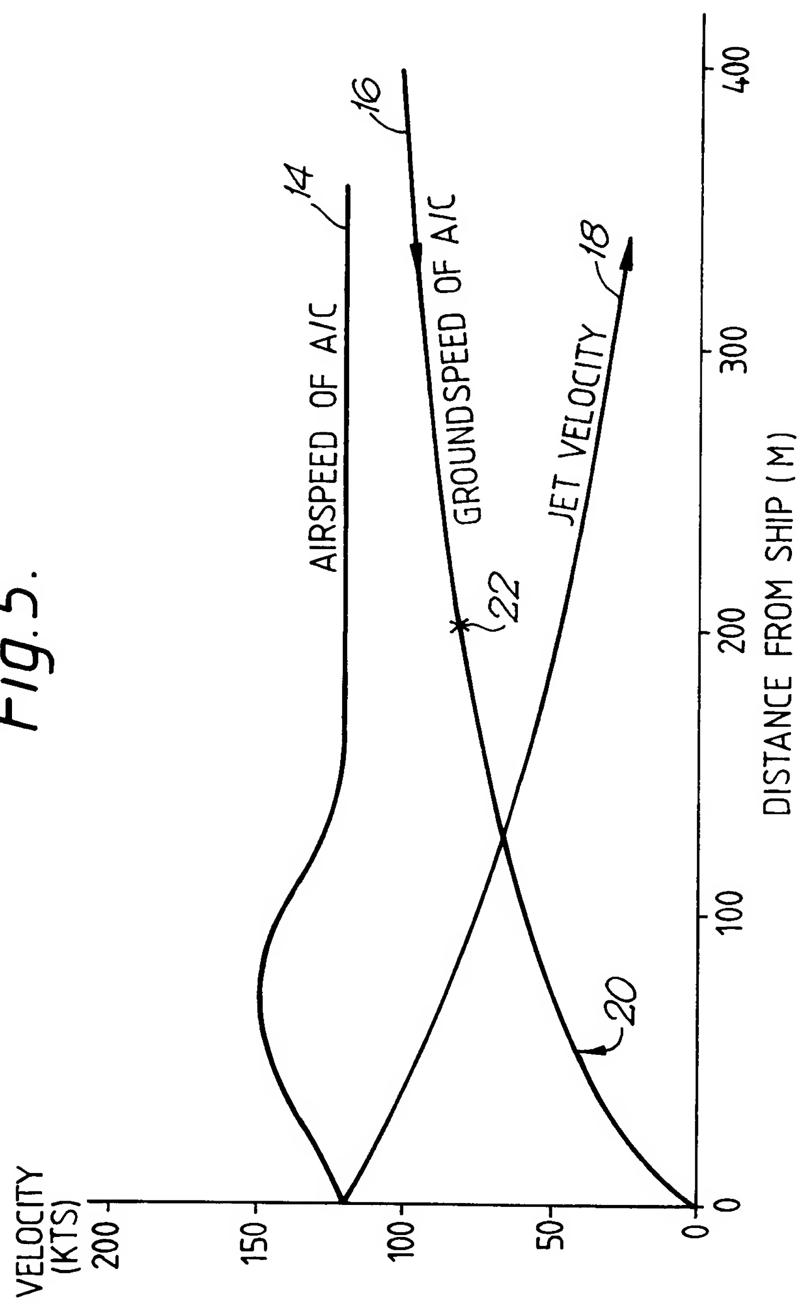


Fig.5.


VELOCITY
(KTS)
200
150
100
50
0
0
100
200
300
400
DISTANCE FROM SHIP (M)
AIRSPEED OF A/C
GROUNDSPEED OF A/C
JET VELOCITY
14
16
18
20
22

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 30 5613

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-1 164 245 (HELDENDRUNG) * column 2, line 38 - column 3, line 5 * ---	1,2,3	B64F1/02
A	GB-A-1 036 015 (BERTIN ET CIE) * page 3, line 39 - line 69 * -----	1,4,5	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B64F
B64C
B63B
B63G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 SEPTEMBER 1993	HAUGLUSTAINE H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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O : non-written disclosure
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E : earlier patent document, but published on, or after the filing date
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